

SECTION 31 23 33**EXCAVATION BACKFILL AND COMPACTION FOR UTILITIES****PART 1: GENERAL****1.01 SECTION INCLUDES**

- A. Trench excavation, backfill, and compaction shall include, but not necessarily be limited to, the excavation, backfill, and compaction of trenches for water mains, and sanitary sewers, shown on the Drawings, and in accordance with the AW Standard Specifications and Details.

1.02 DEFINITIONS

- A. Pipe Foundation: Suitable and stable native soils that are exposed at trench subgrade after excavation to depth of bottom of bedding as shown on Drawings, or foundation backfill material placed and compacted in over-excavations.
- B. Embedment Material/Pipe Bedding: Portion of trench backfill that extends vertically from top of foundation up to level line at bottom of pipe, and horizontally from one trench sidewall to opposite sidewall.
- C. Haunching: Material placed on either side of pipe from top of bedding up to springline of pipe and horizontally from one trench sidewall to opposite sidewall.
- D. Initial Backfill: Portion of trench backfill that extends vertically from springline of pipe (top of haunching) up to level line 12-inches above top of pipe, and horizontally from one trench sidewall to opposite sidewall.
- E. Pipe Embedment Zone: Portion of trench backfill that consists of bedding, haunching and initial backfill.
- F. Trench Zone: Portion of trench backfill that extends vertically from top of pipe embedment up to pavement subgrade or up to final grade when not beneath pavement.
- G. Unsuitable Material: Unsuitable soil materials are the following:
 - 1. Materials that are classified as ML, CL-ML, MH, PT, OH, and OL according to ASTM D2487.
 - 2. Materials that cannot be compacted to required density due to gradation, plasticity, or moisture content.
 - 3. Materials that contain large clods, aggregates, stones greater than 4-inches in any dimension, debris, vegetation, waste or any other deleterious materials.

4. Materials that are contaminated with hydrocarbons or other chemical contaminants.
- H. **Suitable Material:** Suitable soil materials are those meeting specification requirements. Materials mixed with lime, fly ash, or cement that can be compacted to required density and meeting requirements for suitable materials may be considered suitable materials, unless otherwise indicated.
 - I. **Backfill:** Suitable material meeting specified quality requirements placed and compacted under controlled conditions.
 - J. **Ground Water Control Systems:** Installations external to trench, such as well points, eductors, or deep wells. Ground water control includes dewatering to lower ground water, intercepting seepage which would otherwise emerge from side or bottom of trench excavation, and depressurization to prevent failure or heaving of excavation bottom.
 - K. **Surface Water Control:** Diversion and drainage of surface water runoff and rain water away from trench excavation. Rain water and surface water accidentally entering trench shall be controlled and removed as part of excavation drainage.
 - L. **Excavation Drainage:** Removal of surface and seepage water in trench by sump pumping and using drainage layer, as defined in ASTM D2321, placed on foundation beneath pipe bedding or thickened bedding layer of Class I material.
 - M. **Trench Conditions** are defined with regard to stability of trench bottom and trench walls of pipe embedment zone. Maintain trench conditions that provide for effective placement and compaction of embedment material directly on or against undisturbed soils or foundation backfill, except where structural trench support is necessary.
 1. **Dry Stable Trench:** Stable and substantially dry trench conditions exist in pipe embedment zone as result of typically dry soils or achieved by ground water control (dewatering or depressurization) for trenches extending below ground water level.
 2. **Stable Trench with Seepage:** Stable trench in which ground water seepage is controlled by excavation drainage.
 - a. **Stable Trench with Seepage in Clayey Soils:** Excavation drainage is provided in lieu of or to supplement ground water control systems to control seepage and provide stable trench subgrade in predominately clayey soils prior to bedding placement.
 - b. **Stable Wet Trench in Sandy Soils:** Excavation drainage is provided in embedment zone in combination with ground water control in predominately sandy or silty soils.

3. Unstable Trench: Unstable trench conditions exist in pipe embedment zone if ground water inflow or high water content causes soil disturbances, such as sloughing, sliding, boiling, heaving or loss of density.
- N. Sub-trench: Sub-trench is special case of benched excavation. Sub-trench excavation below trench shields or shoring installations may be used to allow placement and compaction of foundation or embedment materials directly against undisturbed soils. Depth of sub-trench depends upon trench stability and safety as determined by the Contractor.
 - O. Trench Dam: Placement of low permeability material in pipe embedment zone or foundation to prohibit ground water flow along trench.
 - P. Over-excavation and Backfill: Excavation of subgrade soils with unsatisfactory bearing capacity or composed of otherwise unsuitable materials below top of foundation as shown on Drawings, and backfilled with foundation backfill material.
 - Q. Foundation Backfill Materials: Natural soil or manufactured aggregate of controlled gradation, and geotextile filter fabrics as required, to control drainage and material separation. Foundation backfill material is placed and compacted as backfill to provide stable support for bedding. Foundation backfill materials may include concrete seal slabs.
 - R. Trench Safety Systems: Includes both protective systems and shoring systems.
 - S. Trench Shield (Trench Box): Portable worker safety structure moved along trench as work proceeds, used as protective system and designed to withstand forces imposed on it by cave in, thereby protecting persons within trench. Trench shields may be stacked if so designed or placed in series depending on depth and length of excavation to be protected.
 - T. Shoring System: Structure that supports sides of an excavation to maintain stable soil conditions and prevent cave-ins, or to prevent movement of ground affecting adjacent installations or improvements.
 - U. Special Shoring: Shoring system meeting special shoring as specified in Paragraph 1.06, Special Shoring Design Requirements, for locations identified on Drawings.

1.03 SCHEDULING

- A. Schedule work so that pipe embedment can be completed on same day that acceptable foundation has been achieved for each section of pipe installation, manhole, or other structures.
- B. The Contractor shall not excavate more trench in any day than can be completed

(facility installed and trench backfilled) in the same day, unless by written permission of AW. AW shall be empowered at any time to require the backfilling of open trenches over completed pipe lines if, in their judgment, such action is necessary.

1.04 SUBMITTALS

- A. Conform to requirements of Section 01 33 00 - Submittal Procedures.
- B. Submit planned typical method of excavation, backfill placement and compaction including:
 - 1. Trench widths
 - 2. Procedures for foundation and pipe zone bedding placement, and trench backfill compaction.
 - 3. Procedures for assuring compaction against undisturbed soil when pre-manufactured trench safety systems are proposed.
- C. Submit backfill material sources and product quality information in accordance with requirements of Section – Utility Backfill Materials.
- D. Submit trench excavation safety program. Identify by name who will be OSHA competent person for excavations. If special shoring system is to be used, include designs for special shoring meeting requirements defined in Paragraph 1.06, Special Shoring Design Requirements contained herein.
- E. Submit record of location of utilities as installed, referenced to survey control points. Include locations of utilities encountered or rerouted. Give stations, horizontal dimensions, elevations, inverts, and gradients.

1.05 TESTS

- A. Geotechnical testing and analysis of backfill materials for soil classification and compaction testing during construction shall be provided by the Contractor and performed by an independent, State-certified, testing company approved by AW. The results of all failing tests shall be communicated to AW immediately. Written results of all tests performed, shall be presented to AW in a timely manner.
- B. Perform backfill material source qualification testing in accordance with requirements of Section – Utility Backfill Materials.
- C. The Contractor will arrange for all in-place moisture/density testing on the project.
- D. Frequency :

Compaction testing shall be performed on random lifts a minimum of every 300 LF unpaved areas and 100 LF in paved areas unless otherwise approved by the AW Project Manager. AW reserves the right to require re-tests if the initial compaction test fails.

1. If ground water is present, at the discretion of the AW Project Manager, compaction testing shall be increased to every 100 LF in unpaved areas.
2. A minimum of one (1) compaction test per lift shall be performed for all backfill operations with less linear footage than specified in 1.05 D.
3. The testing agency shall determine at the time of testing the location of each compaction test within the specified testing length.
4. As an alternative to the compaction testing frequency specified, the Contract shall have the option to demonstrate acceptable compaction at the start of the project.
 - a. At the start of the trenching operation, the Contractor shall demonstrate to the AW representative through the results reported by the accepted testing agency that the compaction density specified can be attained by the compaction equipment and methods the Contractor intends to use.
 - b. Once the method and equipment has been approved, no substitutions will be permitted without AW's approval.
 - c. Additional demonstration of the suitability of the compaction equipment and methods will be required whenever there is a significant change in material characteristics or change in compaction equipment or method.
 - d. Should testing determine that the required density is not being met, or the material is outside the specified moisture range, the Contractor shall, without additional compensation, reexcavate, rework, and/or recompact the particular layer or section until the required density and/or moisture is attained.

E. Compaction

1. The Contractor shall, in unimproved areas outside the public rights-of-way, compact each trench backfill layer in such a manner as to obtain a dense backfill free of voids and not susceptible to undue settlement or depression. Trench backfill extending to not less than 1-foot in depth above the top of pipe shall be compacted to at least 90% of maximum density at a moisture content within 5% of the optimum in accordance with ASTM D1556.

2. Trench backfill within all rights-of-way of improved or paved areas shall be compacted to at least 95% of maximum density at a moisture content within 5%, or local requirements which ever is more stringent, of the optimum moisture in accordance with ASTM D1556. The final 1-foot of trench backfill to pavement subgrade shall be compacted to at least 95% of maximum density at a moisture content within 5% of the optimum in accordance with ASTM D1556.

1.06 SPECIAL SHORING DESIGN REQUIREMENTS

- A. Have special shoring designed or selected by Contractor's Professional Engineer registered in the State the project is being completed to provide support for sides of excavations, including soils and hydrostatic ground water pressures as applicable, and to prevent ground movements affecting adjacent installations or improvements such as structures, pavements and utilities. Special shoring may be a premanufactured system selected by Contractor's Professional Engineer to meet project site requirements based on manufacturer's standard design.
- B. The requirement for special shoring shall be determined by AW for all excavations within 10-feet of an AW owned asset.

PART 2: PRODUCTS

2.01 EQUIPMENT

- A. Perform excavation with hydraulic excavator or other equipment suitable for achieving requirements of this Section.
- B. Heavy compaction equipment shall not be used until adequate cover is attained. in order to prevent damage to pipes, conduits, or ducts.
- C. Use trench shields or other protective systems or shoring systems, including special shoring systems as referenced in Paragraph 1.06, which are designed and operated in accordance with all Local, State, and Federal (including OSHA) standards and regulations.

2.02 MATERIAL CLASSIFICATIONS

- A. Embedment and Trench Zone Backfill Materials: Conform to classifications and product descriptions of Section – Utility Backfill Materials.
- B. Concrete Encasement: Concrete used for encasement or caps shall have a minimum compressive strength of 3,000 psi.
- C. Concrete Backfill: Also known as flowable fill. Flowable fill must be “excavatable” as defined by the National Ready Mixed Association as having a compressive strength not exceeding 150 psi.

- D. Concrete for Trench Dams: Concrete backfill or 3 sack premixed (bag) concrete.

PART 3: EXECUTION

3.01 STANDARD PRACTICE

- A. Install flexible pipe, including "semi-rigid" pipe, to conform to standard practice described in ASTM D2321, and as described in this Section. Where an apparent conflict occurs between standard practice and requirements of this Section, this Section governs.
- B. Install rigid pipe to conform to standard practice described in ASTM C12, and as described in this Section. Where an apparent conflict occurs between standard practice and requirements of this Section, this Section governs.

3.02 PREPARATION

- A. Maintain barricades and warning lights for streets and intersections affected by Work, and that are considered hazardous to traffic movements as specified in the approved traffic control plan for the project.
- B. It is the Contractor's responsibility to obtain all required permits for excavation to include a Traffic Control Plan approved by the local governing authority.
- C. Perform work to conform to applicable safety standards and regulations, as outlined in current OSHA, State and local regulations.
- D. Immediately notify agency or company owning any existing utility line which is damaged, broken, or disturbed. Obtain approval from AW Project Manager and agency for any repairs or relocations, either temporary or permanent.
- E. Remove existing pavements and structures, including sidewalks and driveways, to conform to local (local, State DOT, DPW, CE, etc.) requirements.
- F. Install and operate necessary dewatering and surface-water control measures. Provide stable trench to allow installation in accordance with Specifications.
- G. Maintain permanent benchmarks, monuments, and other reference points. Unless otherwise directed in writing, at the expense of the Contractor a Licensed Surveyor shall replace those which are damaged or destroyed in accordance with the requirements of the AW and local or State requirements.

3.03 CRITICAL LOCATION INVESTIGATION

- A. Horizontal and vertical location of various underground lines shown on Drawings, including but not limited to water lines, gas lines, storm sewers, sanitary sewers, telecommunication lines, electric lines or power ducts, pipelines, concrete and

debris, are based on best information available but are only approximate locations.

- B. The Contractor is responsible for coordinating all utility locates within the Limits of Disturbance per the standard procedures for the project location (One call system, DPW, CE, Utility Company Coordination, etc.)
- C. The Contractor is responsible for verifying the location of existing utilities in manner that complies with all local, State and Federal regulations. Use extreme caution and care when uncovering these lines.
- D. Notify AW Project Manager in writing immediately upon identification of obstruction.
- E. Notify involved utility companies of date and time that investigation excavation will occur and request that their respective utility lines be marked in field. Comply with utility or pipeline company requirements that their representative be present during excavation. Provide AW Project Manager written 48 hours notice prior to field excavation or related work.

3.04 PROTECTION

- A. Protect trees, shrubs, lawns, existing structures, and other permanent objects outside of grading limits and within grading limits as designated on Drawings.
- B. Protect and support above-grade and below-grade utilities which are to remain.
- C. Restore damaged permanent facilities to a condition equal to or better than pre-construction conditions unless replacement or abandonment of facilities is indicated on Drawings.
- D. Take measures to minimize erosion of trenches. Do not allow water to pond in trenches. Where slides, washouts, settlements, or areas with loss of density or pavement failures or potholes occur, repair, recompact, and pave those areas at no additional cost to AW.
- E. Protection of Property and Structures: The Contractor shall be responsible for all damage and assume all expense for direct or indirect injury caused by his work, to above ground facilities or below ground facilities shown on the Drawings. The Contractor shall, at his own expense, sustain in place and protect from direct or indirect injury all existing facilities in the vicinity of the excavation, whether above or below the ground, or that may appear in the trench. The Contractor shall be responsible for the implementation of protective measures associated with the presence or proximity of pipes, poles, tracks, walls, buildings, property markers, and other structures and property of every kind and description in or over his trenches or in the vicinity of his work whether above or below the surface of the ground.

3.05 EXCAVATION

- A. Except as otherwise specified or shown on Drawings, install underground utilities in open cut trenches with vertical sides.
- B. Perform excavation work so that pipe, conduit, and ducts can be installed to depths and alignments shown on Drawings. Avoid disturbing surrounding ground and existing facilities and improvements.
- C. Trenches shall be wide enough to allow for compaction equipment.
- D. Use sufficient trench width or benches above embedment zone for installation of well point headers or manifolds and pumps where depth of trench makes it uneconomical or impractical to pump from surface elevation. Provide sufficient space between shoring cross braces to permit equipment operations and handling of forms, pipe, embedment and backfill, and other materials.
- E. Upon discovery of unknown utilities, badly deteriorated utilities not designated for removal, or concealed conditions notify AW Project Manager immediately
- F. Trench Support:
 - 1. The Contractor shall support the sides and ends of all excavations wherever necessary with braces, sheeting, shoring or stringers, trench boxes, or other acceptable excavation support systems. All timbering shall be installed by persons skilled in such work and shall be so arranged that it may be withdrawn as backfilling proceeds, without injury to the utility or structure constructed or to any roadbed or adjacent structure or property.
 - 2. All work shall be performed in accordance with the latest OSHA requirements.
 - 3. All timbering in excavations, trench boxes, or excavation support systems shall be withdrawn as the backfilling is being done, except where and to such extent as the AW Project Manager shall order in writing that said timbering or excavation support system be left in place or where the AW Project Manager permits the trench support to be left in place at the Contractor's expense and upon his request. The Contractor shall cut off any sheeting left in place 2 feet below finished grade and shall remove the material cut off without compensation therefore.
 - 4. The support of the trench shall be the sole responsibility of the Contractor.
 - 5. Removal or Moving of trench shoring shall be performed so that pipe, and backfill materials, after placement and compaction, are not damaged nor

disturbed, nor degree of compaction reduced. Re-compact after shoring is moved if soil is disturbed.

6. The Contractor shall coordinate and provide safe access at all times to all inspecting and testing activities for AW and AW-authorized representatives.

3.06 HANDLING EXCAVATED MATERIALS

- A. Use only excavated materials, which are suitable as defined in this Section and conforming to Section – Utility Backfill Materials. Place material suitable for backfilling in stockpiles per the most current OSHA standards.
- B. When required, provide additional backfill material conforming to requirements of Section – Utility Backfill Materials.
- C. Stockpile locations shall be pre-approved by the AW Project Manager and the local governing authority.
- D. All excavated material not used as backfill the same day as excavated shall be removed from the site and/or stockpiled in an area pre-approved by the AW Project Manager.

3.07 TRENCH FOUNDATION

- A. The Contractor shall, before any pipe or appurtenance is installed, fill all unauthorized depressions or irregularities in the bottom of the trench or tunnel with firmly compacted embankment or other approved material.
- B. It shall be the Contractor's responsibility to adequately control water that may be present in the excavation. Contractor shall provide for the disposal of water removed from excavations in such a manner not to cause damage to public or private property or to any portion of the Work completed or in progress or cause any impediment to the use of any area by the public. Nor shall the Contractor discharge any flushing or ground water or any material of any nature into existing sanitary sewer system during construction of the facilities. All water shall be discharged through an approved sediment control device and in compliance with NPDES and SPDES discharge requirements.
- C. Notify AW Project Manager immediately when unsatisfactory material is encountered on trench bottom. With AW approval, up to 12 -inches of additional undercut may be permitted to achieve suitable trench bottom. If the additional undercut does not result in a satisfactory trench bottom, the Contractor shall obtain a bedding design prepared by a Geotechnical Engineer licensed in the State in which the project is being constructed.

- D. Perform over excavation, if directed by AW Project Manager, in accordance with Paragraph 3.07.C above. Removal of material maybe required. Even though Contractor has not determined material to be unsuitable.
- E. Trench dams shall be installed as determined by the AW Project Manager when ground water is encountered.

3.08 PIPE EMBEDMENT, PLACEMENT, AND COMPACTION

- A. The following material shall be used for the pipe embedment zone (bedding, haunching, and initial backfill) based on project location.

Location	Water Main & Sanitary Force Main			Gravity Sewer
	DIP	PVC	HDPE	
Alabama (Fort Rucker)	Native Material	Native Material	Native Material	Native Material
Illinois (Scott AFB)	Class II, Type A	Class II, Type A	Class II, Type A	Class II, Type A
Kansas (Fort Leavenworth)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)
New York (West Point)	AASHTO #9 (3/8" stone/washed)	AASHTO #9 (3/8" stone/washed)	AASHTO #9 (3/8" stone/washed)	AASHTO #9 (3/8" stone/washed)
Louisiana (Ft Polk)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)
Maryland (Ft Meade)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)
Oklahoma (Fort Sill)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)
Texas (Fort Hood & Joint Base San Antonio)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)	Sand	AASHTO #9 (3/8" stone/washed gravel)
Virginia (Fort AP Hill & Fort Belvoir)	VDOT 21a or 21b	VDOT 21a or 21b	VDOT 21a or 21b	VDOT 57 or 68

Utah (Hill Air Force Base)	2" stone/washed gravel	3/4" stone/washed gravel	3/4" stone/washed gravel	2" stone/washed gravel
California (Vandenberg Air Force Base)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)
Missouri (Fort Leonard Wood)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)
New Jersey (Picatinny Arsenal)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)
Ohio (Wright-Pat Air Force) Base	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)	AASHTO #9 (3/8" stone/washed gravel)

- B. Remove loose, sloughing, caving, or otherwise unsuitable soil from bottoms and sidewalls of trenches immediately prior to placement of embedment materials.
- C. Place embedment including bedding, haunching, and initial backfill as shown on Drawings.
- D. For pipe installation, manually spread embedment materials around pipe to provide uniform bearing and side support when compacted. Protect flexible pipe from damage during placing of pipe zone bedding material. Perform placement and compaction directly against undisturbed soils in trench sidewalls, or against sheeting which is to remain in place.
- E. Do not place trench shields or shoring within height of embedment zone unless means to maintain density of compacted embedment material are used. If moveable supports are used in embedment zone, lift supports incrementally to allow placement and compaction of material against undisturbed soil.
- F. Place geotextile to prevent particle migration from in-situ soil into open-graded (Class I) embedment materials or drainage layers.
- G. Do not damage coatings or wrappings of pipes during backfilling and compacting operations. When embedding coated or wrapped pipes, do not use crushed stone or other sharp, angular aggregates.
- H. Place haunching material around pipe and compact per the pipe manufacture's recommendation to provide uniform bearing and side support. The haunching shall be installed in a manner that prevents the pipe from moving.
- I. Place electrical conduit, if used, directly on foundation without bedding.
- J. The method of compaction of the embedment zone material shall comply with the pipe manufacture's recommendation. Water tamping is not allowed.

3.09 TRENCH ZONE BACKFILL PLACEMENT AND COMPACTION

- A. Place backfill for pipe or conduits and restore surface as soon as practicable. Leave only minimum length of trench open as necessary for construction.
- B. For water and sewer lines under existing pavement, use an aggregate base backfill up to the pavement base or sub grade. Aggregate base shall meet the specifications of and be installed per the Department of Transportation regulations for the State in which the project is located.
- C. Unless otherwise shown on Drawings, for trench excavations not under pavement, random backfill of suitable material may be used in trench zone.
 - 1. Clay Soils may be used as trench zone backfill outside paved areas.
 - 2. Place in maximum 8-inch thick lift.
 - 3. Compact per Paragraph 1.05 of this specification section.
 - 4. Moisture content as necessary to achieve density.
- D. For electric conduits, remove form work used for construction of conduits before placing trench zone backfill.

3.10 MANHOLES, JUNCTION BOXES AND OTHER PIPELINE STRUCTURES

- A. Manholes, junction boxes and other pipeline structures shall have bedding consisting of a minimum of 1' compacted $\frac{3}{4}$ " to 1" clean stone. The compacted $\frac{3}{4}$ " to 1" stone shall be installed horizontally out from the base to the limits of the excavation (minimum 1'), and extend up to a minimum of 1' above the pipe or base, which ever is greater (does not include the upper connection of a drop inlet). The stone shall be installed to a uniform depth around the entire perimeter of the structure. The remainder of the backfill shall be installed per section 3.09 Trench Zone Backfill Placement and Compaction to include paved and unpaved area requirements.

3.11 DISPOSAL OF EXCESS MATERIAL

- A. Dispose of excess materials in accordance with requirements of the contract documents, State and local requirements.

END OF SECTION 31 23 33